

TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT
(Under 37 CFR 1.97(b) or 1.97(c))

Docket No.
S-96306

In Re Application Of:
Rau et al

MAY 14 2001

C49
JL

Serial No. 09/759,781 Filing Date 1/11/2001

Examiner

Group Art Unit
1764

Title:

Method and Apparatus for Extracting and Sequestering Carbon Dioxide

RECEIVED

MAY 17 2001

TC 1700

37 CFR 1.97(b)

- The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application; within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; or before the mailing date of a first Office Action on the merits, whichever event occurs last.

37 CFR 1.97(c)

- The Information Disclosure Statement submitted herewith is being filed after three months of the filing of a national application, or the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; or after the mailing date of a first Office Action on the merits, whichever occurred last but before the mailing date of either:
 1. a Final Action under 37 CFR 1.113, or
 2. a Notice of Allowance under 37 CFR 1.311,

whichever occurs first.

Also submitted herewith is:

a certification as specified in 37 CFR 1.97(e);

OR

the fee set forth in 37 CFR 1.17(p) for submission of an Information Disclosure Statement under 37 CFR 1.97(c).



PATENT
S-96306

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:) Group Art Unit: 1764
Rau et al) Examiner:
Serial No. 09/759,781)
Filing Date: January 11, 2001)
Title: Method and Apparatus for)
Extracting and Sequestering)
Carbon Dioxide)

RECEIVED
MAY 17 2001
TC 1700

INFORMATION DISCLOSURE STATEMENT

Honorable Commissioner of Patents
Washington, D.C. 20231

Sir:

Attached hereto is Form PTO-1449 listing documents believed relevant to the subject application.

The present application is a continuation in part claiming the benefit of U.S. application, 09/314,220, filed 5/19/99, which in turn claimed the benefit of provisional application 60/096,846, filed 8/18/98. IDS submittals for application 09/314,220 were made on 8/31/99, 3/15/2000 and 6/15/2000.

It is believed that this disclosure complies with the requirements of 37 C.F.R. §§ 1.56, 1.97 and 1.98 and the Manual of Patent Examining Procedures § 609. If for some reason the examiner considers otherwise, it is respectfully requested that the undersigned be called so that any deficiencies can be remedied.

Some of the documents may have markings thereon. No significance is meant to be attached to the markings. Copies of some of the documents cited are not included herein, since they were cited and/or provided previously for parent case 09/314,220.

These documents are not necessarily analogous art.

The relevance of each document will now be discussed.

Patents

Document A1 (U.S. Patent 3,511,595) This document was cited and submitted in an IDS submitted 6/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A2 (U.S. Patent 3,660,023) This document was cited and submitted in an IDS submitted 6/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A3 (U.S. Patent 3,883,639) discusses removal from sulfur from exhaust gas utilizing limestone, carbon dioxide and a soluble sulfate. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A4 (U.S. Patent 3,988,422) This document was cited and submitted in an IDS submitted 6/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A5 (U.S. Patent 4,160,810) discusses the absorption of acid gases in an aqueous alkaline scrubbing solution, and desorbed by steam stripping. This document was cited and submitted in an IDS submitted 3/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A6 (U.S. Patent 4,187,279) This document was cited and submitted in an IDS submitted 6/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A7 (U.S. Patent 4,247,525) discusses removing sulfur oxides from exhaust gas via contact with a sprayed aqueous solution of sodium carbonate and/or sodium bicarbonate. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A8 (U.S. Patent 4,272,498) discusses conversion of limestone to an unstable form via contact with carbon dioxide to form an activated calcium carbonate slurry, said slurry then being used to scrub flue gases. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A9 (U.S. Patent 4,367,258) discusses decarbonating gas via sequential washings with an alkali metal carbonates solution and a alkanolamine solution. This document was cited and submitted in an IDS submitted 3/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A10 (U.S. Patent 4,376,101) discusses removal of acidic gases containing carbon dioxide from a gaseous mixture by absorbing CO₂ with an aqueous solution comprising a basic alkali metal salt or hydroxide and an activator or promoter system for the salt or hydroxide. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A11 (U.S. Patent 4,376,102) discusses removal of acidic gases containing carbon dioxide from a gaseous mixture by absorbing CO₂ with an aqueous solution comprising a basic alkali metal salt or hydroxide and an activator or promoter system for the salt or hydroxide. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A12 (U.S. Patent 4,405,578) discusses removal of acidic gases containing carbon dioxide from a gaseous mixture by absorbing CO₂ with an aqueous solution comprising a basic alkali metal salt or hydroxide and an activator or promoter system for

the salt or hydroxide. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A13 (U.S. Patent 4,496,371) discusses the removal of hydrogen sulfide and carbon dioxide from a gas stream via utilizing an aqueous carbonate solution. This document was cited and submitted in an IDS submitted 3/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A14 (U.S. Patent 4,510,124) This document was cited and submitted in an IDS submitted 6/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A15 (U.S. Patent 4,708,855) discusses scrubbing oxides of sulfur and nitrogen from exhaust gas via contacting the exhaust gas with sprayed alkali water. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A16 (U.S. Patent 4,716,027) discusses scrubbing exhaust gas via contacting the exhaust gas, cement kiln dust and water. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A17 (U.S. Patent 5,006,323) discusses desulfurization of combustion gases via calcining a compound, processing the calcined compound with flyash to form an absorbent, and treating the combustion gases with the absorbent. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A18 (U.S. Patent 5,059,406) discusses a flue gas desulfurization process via contacting the gas with an alkali metal compound. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A19 (U.S. Patent 5,100,633) discusses a process for scrubbing acid-forming gases which include SO₂ and CO₂ from an exhaust gas stream through reactions with alkaline

solutions formed from the waste ash from biomass burning. The resulting alkali metal salts are then precipitated or dewatered forming solid, possibly useful waste products. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A20 (U.S. Patent 5,192,518) discusses desulfurizing exhaust gas via use of a calcium carbonate slurry. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A21 (U.S. Patent 5,261,490) cited by Examiner in parent U.S. application, 09/314,220, filed 5/19/99.

Document A22 (U.S. Patent 5,429,808) discusses desulfurizing exhaust gas via use of a sprayed absorbent slurry containing a calcium compound. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A23 (U.S. Patent 5,584,905) This document was cited and submitted in an IDS submitted 6/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A24 (U.S. Patent 5,639,430) cited by Examiner in parent U.S. application, 09/314,220, filed 5/19/99.

Document A25 (U.S. Patent 5,686,053) discusses desulfurizing exhaust gas via use of an absorbing liquid. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document A26 (U.S. Patent 5,788,944) discusses use of an absorbing liquid to absorb sulfur oxide from combustion exhaust gas. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Foreign Patents

Document B1 (Patent WO9825688) discusses the absorption of carbon dioxide using a solution of potassium carbonate in the presence of diethanol amine as a catalyst to produce potassium bicarbonate. This document was cited and submitted in an IDS submitted 3/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document B2 (Patent GB2284203) discusses the use of dolomite in an aqueous solution containing sodium chloride to produce sodium bicarbonate from carbon dioxide gas. This document was cited and submitted in an IDS submitted 3/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document B3 (Patent EP 487102) This document was cited and submitted in an IDS submitted 6/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document B4 (Patent GB819215) This document was cited and submitted in an IDS submitted 6/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document B5 (Patent GB1305718) This document was cited and submitted in an IDS submitted 6/15/2000 for parent U.S. application, 09/314,220, filed 5/19/99.

Document B6 (Patent WO 98/55210) cited by Examiner in parent U.S. application, 09/314,220, filed 5/19/99.

Journal Articles

Document C1, "Carbon Dioxide Recovery and Disposal From Large Energy Systems", H. Herzog and E. Drake, published in Annual Reviews of Energy and Environment (U.S.A.) Vol. 21, p 145-166, dated 1996, discusses consumption of CO₂ contained in emissions from fossil fuel combustion or other gas streams. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C2, "Mitigation of CO₂ by Chemical Conversion: Plausible Chemical Reactions and Promising Products", X. Xiaoding and J.A. Moulijn, published in Energy and Fuels (U.S.A.), Vol. 10, No. 2, p 305-325, dated 1996, discusses consumption of CO₂ contained in emissions from fossil fuel combustion or other gas streams. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C3 "The Fixation of Carbon Dioxide in Inorganic and Organic Chemicals", M. Aresta, published in Energy Conversion and Management (Great Britain), Vol.. 34, No. 9-11, p. 745-752, dated 1993, reviews various means of reacting carbon dioxide with other compounds to control emissions of CO₂ to the atmosphere. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C4, "The Carbonate-Silicate Geochemical Cycle and its Effect on Atmospheric Carbon Dioxide Over the Last 100 Million Years", R.A. Berner, A.C. Lasaga, and R.M. Garrels, published in American Journal of Science (U.S.A.), Vol. 283, p 641-683, dated September 1983, discusses the reaction of certain carbonate and silicate minerals with CO₂ via the "rock weathering" phenomenon that plays a major role in controlling atmospheric CO₂ on geologic time scales . This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C5, "Marine Carbonate Formations: Their role in Mediating Long-Term Ocean-Atmosphere Carbon Dioxide Fluxes - A Review", C.N. Murray and T.R.S. Wilson, published in Energy Conversion and Management (Great Britain), Vol. 38, Supple., p. S287-S294, dated 1997, reviews the interaction between marine carbonate and carbon dioxide under natural conditions and how this affects atmospheric carbon dioxide levels over geologic time scales. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C6, "Multiple timescales for neutralization of fossil fuel CO₂", D. Archer, H. Keshgi, and E. Maier-Reimer, published in Geophysical Research Letters (U.S.A.), Vol.

24, No. 4, p. 405-408, dated February 15, 1997, discusses various geochemical reactions between atmospheric carbon dioxide and carbonates on land and in the ocean, and the timescales of these reactions in affecting atmospheric carbon dioxide. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C7, "CO₂ Fixation by Artificial Weathering of Waste Concrete and Coccolithophorid Algae Cultures", H. Takano and T. Matsunaga, published in Energy Conversion Management (Great Britain), Vol. 36, No. 6-9, p 697-700, dated 1995, discusses fixation and storage of CO₂ by artificial weathering of waste concrete in combination with coccolithophorid algae cultures. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C8, "Evaluation Strategies for Chemical and Biological Fixation/Utilization Processes of Carbon Dioxide", T. Kojima, published in Energy Conversion Management (Great Britain), Vol. 36, No. 6-9, p 881-884, dated 1995, discusses various mechanisms of rock weathering to fix CO₂. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C9, "Absorption and Fixation of Carbon Dioxide by Rock Weathering", T. Kojima, A. Nagamine, N. Ueno and S. Uemiya, published in Energy Conversion Management (Great Britain), Vol. 38, Suppl., p S461-S466, dated 1997, discusses CO₂ fixation by silicate rock weathering. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C10, "Carbon Disposal in Carbonate Minerals", K.S. Lackner, C.H. Wendt, D.P. Butt, E.L. Joyce, D.H. Sharp, published in Energy (Great Britain), Vol. 20, No. 11, p 1153-1170, dated 1995, discusses sequestering of CO₂ as carbonate by reaction with minerals rich in calcium and magnesium oxides. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C11, "Progress on Binding CO₂ in Mineral Substrates" , K.S. Lackner, D.P. Butt, and C.H. Wendt, published in Energy Conversion and Management (Great Britain), Vol. 38, No. 11, p S259-S264, dated 1997, provides an update to the preceding citation. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C12, "CO₂ Recovery From Flue Gas by an Ecotechnological (Environmentally Friendly) System", T. Chohji, M. Tabata, and E. Hirai, published in Energy (Great Britain), Vol. 22, No. 2/3, p 151-159, dated 1997, discusses reacting flue gas CO₂ with water and soil to ultimately precipitate and sequester the CO₂ as carbonate. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C13, "Sequestering Atmospheric Carbon Dioxide by Increasing Ocean Alkalinity", H. Kheshgi, published in Energy (Great Britain), Vol. 20, No. 9, p 915-922, dated 1995, discusses adding calcium oxide to the ocean as a means of increasing the CO₂ absorption capacity of the ocean. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C14, H. N. Soud and M. Takeshita, FGD Handbook, Second Edition, IEA Coal Research, London, chapter 3, p. 25-43, dated January 1994, discusses gas/water/calcium carbonate (limestone) reactors used in desulfurization of power plants exhaust. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C15, "Geochemistry of Sedimentary Carbonates", Elsevier Science Publishers (Netherlands), p. 1-10, 72-86, dated 1990, J.W. Morse and F.T. Mackenzie, discusses chemical reactions involving CO₂ gas, water, and carbonate minerals (principally calcium carbonate) focusing on dissolution or precipitation of solid carbonate under various conditions. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C16, "A Continuous and Mechanistic Representation of Calcite Reaction-Controlled Kinetics in Dilute Solutions at 25°C and 1 Atm Total Pressure", T. Arakaki and A. Mucci, published in Aquatic Geochemistry (Netherlands), Vol. 1, p 105-130, dated 1995, discusses chemical reactions involving CO₂ gas, water, and carbonate minerals (principally calcium carbonate) focusing on dissolution or precipitation of solid carbonate under various conditions. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C17, "CO₂ Capture, Reuse, and Storage Technologies for Mitigating Global Climate Change, Herzog et al, White Paper by Massachusetts Institute of Technology (U.S.A.), p 34, dated January 1997, mentions the use of carbon dioxide to form carbonates. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C18, "A Geological Perspective on Global Warming and the Possibility of CO₂ Removal as Calcium Carbonate Mineral" , Dunsmore, Energy Conversion Management (Great Britain), Vol 33, No. 5-8, p 565-572, dated 1992, discloses the use of carbon dioxide to form carbonates. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C19, "Carbon Sequestration - State of the Science", Working paper for roadmapping future carbon sequestration R&D, U.S. DOE Office of Science/Office of Fossil Energy (U.S.A.), dated February 1999, p 3-13 to 3-16, discloses use of carbonates to sequester carbon dioxide. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document C20, IEA 2000 "Capture of CO₂ Using Water Scrubbing", International Energy Agency, Gloucestershire, UK. Detailed analysis of the use of seawater scrubbing to absorb flue gas CO₂. On pg. 2-4 and 2-5 a brief analysis of the Rau and Caldeira (1999) method of reacting CO₂ with seawater and limestone is presented.

Document C21, D.O.E. 1999. Carbon Sequestration Research and Development. U.S. Dept. of Energy, Wash., D.C. Review of carbon sequestration technologies. Pg. 3-14 mentions the carbonate dissolution option.

Document C22, Wong, C.S. and S. Hirai. 1997. Ocean Storage of Carbon Dioxide - A Review of Oceanic Carbonate and CO₂ hydrate Chemistry. International Energy Agency, Cheltenham, UK. pg. 54-58 discusses the potential of carbonate naturally occurring in the ocean to neutralize anthropogenic CO₂.

Document C23, Golomb, G. and A. Angelopoulos., "A Benign Form of CO₂ Sequestration in the Ocean", 5th International Conf on Greenhouse Gas Control Technologies, U.S.A., see: <http://www.ieagreen.org.uk/programe.htm>. Paper on the use of limestone particles to make an emulsion with CO₂ as a deep ocean CO₂ sequestration technique. Treats pre-concentrated CO₂. To be published in a Proceedings volume. I Copy of preprint provided.

Document C24, Smith, H.J. 2000. Ocean Dumping of CO₂. *Science* 287: 769, U.S.A., Feb. 4, 2000. Brief review of Caldeira and Rau (2000), document D6.

Document C25, Golomb D . 1997. A fizz-sics solution: Use limestone to cure lake's CO₂ problem, Physics Today (U.S.A.) 50 (2): 15-15. Advocates dropping chunks of limestone into Lake Nios to neutralize CO₂ buildup on lake bottom.

OTHER INFORMATION

Applicant wishes to advise the examiner of the following.

Document D1, a journal article by the inventors describing aspects of this invention was published in the journal Science and Technology Review (U.S.A.), December 1998, entitled "Energy To Keep Everything Running". This publication does not constitute a

statutory bar since this present patent application claims the benefit of parent case 09,314,220 filed 5/19/99 which in turn claims the benefit of U.S. Provisional Application # 60/096,846 filed 8/18/98. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document D2, abstract of a paper entitled "Geochemical implications of the carbonate-dissolution method for ocean disposal of carbon dioxide" describing aspects of this invention was presented by one of the inventors at the "Second International Symposium on CO₂ in the Ocean" conference January 18-22, 1999 in Tsukuba, Japan. This publication does not constitute a statutory bar since this present patent application claims the benefit of parent case 09,314,220 filed 5/19/99 which in turn claims the benefit of U.S. Provisional Application # 60/096,846 filed 8/18/98. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document D3, a journal article by the inventors describing aspects of this invention was issued by Lawrence Livermore National Laboratory (LLNL), U.S.A. as UCRL-JC-132228. Entitled "Enhanced Carbonate Dissolution: A Means of Sequestering Waste CO₂ as Ocean Bicarbonate", it was catalogued by the LLNL library on March 15, 1999. This same article was published in the journal Energy Conversion and Management (Great Britain), vol. 40, 1999, pp. 1803-1813. This publication does not constitute a statutory bar since this present patent application claims the benefit of parent case 09,314,220 filed 5/19/99 which in turn claims the benefit of U.S. Provisional Application # 60/096,846 filed 8/18/98. This document was cited and submitted in an IDS submitted 8/31/99 for parent U.S. application, 09/314,220, filed 5/19/99.

Document D4, Nojiri, Y. 1999. Proceedings of the 2nd International Symposium: CO₂ in the Oceans. National Institute for Environmental Studies, Tsukuba, Japan. pg. 429-438 containing the paper ("Geochemical Implications of the Carbonate-Dissolution Method for Ocean Disposal of Carbon Dioxide") given by one of the inventors on carbonate dissolution as a sequestration option. The paper describes aspects of the invention. This

publication does not constitute a statutory bar since this present patent application claims the benefit of parent case 09,314,220 filed 5/19/99 which in turn claims the benefit of U.S. Provisional Application # 60/096,846 filed 8/18/98.

Document D5, Ken Caldeira and Greg H. Rau, journal article describing aspects of this invention was published in the journal *Geophysical Research Letters*, American Geophysical Union (U.S.A.) January 15, 2000, Vol. 27, No. 2, entitled "Accelerating carbonate dissolution to sequester carbon dioxide in the ocean: Geochemical implications". This publication does not constitute a statutory bar since this present patent application was filed by express mail to the USPTO on 1/11/2001.

Document D6, Rau, G.H. and K. Caldeira. 1999. "Enhanced Carbonate Dissolution as a Means of Sequestering Carbon Dioxide in the Ocean". Abstract published in *Transaction, American Geophysical Union* (Great Britain) 80(49): 213, discloses aspects of the invention. Paper was presented orally at conference "2000 Ocean Sciences Meeting", January 24-28, 2000 in San Antonio, Texas. Copy is not provided as material is substantively cumulative to documents D3 and D5. This publication does not constitute a statutory bar since this present patent application claims the benefit of parent case 09,314,220 filed 5/19/99 which in turn claims the benefit of U.S. Provisional Application # 60/096,846 filed 8/18/98.

Document D7, Rau, G.H., B. Downs, K. Caldeira, and H. Sarv. 2000. "Enhanced Carbonate Dissolution as a Means of Sequestering Carbon Dioxide in the Ocean". Abstract published in *Transaction, American Geophysical Union* (Great Britain) 81(48): 283, discloses aspects of the invention. Paper was presented orally at conference "2000 Fall Meeting", December 15-19, 2000 in San Francisco, California. Copy is not provided as material is substantively cumulative to documents D3 and D5. This publication does not constitute a statutory bar since this present patent application claims the benefit of parent case 09,314,220 filed 5/19/99 which in turn claims the benefit of U.S. Provisional Application # 60/096,846 filed 8/18/98.

Respectfully Submitted,

5/7/01

Date

Randall W. Chang

Randall W. Chang

Registration Number 40,946

INFORMATION DISCLOSURE CITATION
(Use several sheets if necessary)

MAY 14 2001

Docket Number (Optional) S-96306 Application Number 09/759,781

Applicant(s)
Rau et al

Filing Date 1/11/2001 Group Art Unit 1764



U.S. PATENT DOCUMENTS

*EXAMINER INITIAL	REF	DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
	A1	3,511,595	5/12/70	Fuchs	23	4	
	A2	3,660,023	5/2/72	Frevel et al	23	150	
	A3	3,883,639	5/13/75	Cronkright et al	423	241	
	A4	3,988,422	10/26/76	Kruger	423	232	RECEIVED MAY 17 2001
	A5	4,160,810	7/10/79	Benson et al	423	220	TC 1700
	A6	4,187,279	2/5/80	Rimpi	422	185	
	A7	4,247,525	1/27/81	Voeste	423	242	
	A8	4,272,498	6/9/81	Faatz	423	242	
	A9	4,367,258	1/4/83	Lagana et al	423	22/	
	A10	4,376,101	3/8/83	Sartori et al	423	223	
	A11	4,376,102	3/8/83	Thaler Et al	423	223	

FOREIGN PATENT DOCUMENTS

REF	DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	Translation	
						YES	NO
B1	WO9825688	6/18/98	European patent	B01d53	62		
B2	GB2284203	5/31/95	United Kingdom	B01D53	62		
B3	EP 487102	5/27/92	EPO	B01D53	34		
B4	GB819215	9/2/59	Germany	55	2		
B5	GB1305718	2/7/72	United Kingdom	B01D53	34		

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

EXAMINER

DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE CITATION

(Use several sheets if necessary)

MAY 14 2001

Docket Number (Optional)
S-96306Application Number
09/759,781

Applicant(s)

Rau et al

Filing Date

1/11/2001

Group Art Unit

1764

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL	REF	DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
	A12	4,405,578	9/20/83	Sartori et al	423	223	
	A13	4,496,371	1/29/85	Urban et al	48	197	
	A14	4,510,124	4/9/85	Sears et al	423	437	
	A15	4,708,855	11/24/87	Morrison	423	231	
	A16	4,716,027	12/29/87	Morrison	423	244	2001
	A17	5,006,323	4/9/91	Johnson	423	244	TC 1700
	A18	5,059,406	10/22/91	Sheth et al	423	244	
	A19	5,100,633	3/31/92	Morrison	423	225	
	A20	5,192,518	3/9/93	Ukawa et al	423	244.08	
	A21	5,261,490	11/16/93	Ebinuma	166	266	
	A22	5,429,808	7/4/95	Kuroda et al	422	176	

FOREIGN PATENT DOCUMENTS

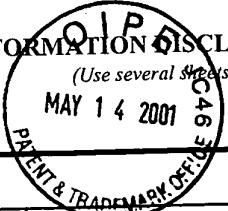
	REF	DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	Translation	
							YES	NO
	B6	WO9855210	12/10/98	European patent	B01D53	62		

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

EXAMINER

DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.



INFORMATION DISCLOSURE CITATION

(Use several sheets if necessary)

MAY 14 2001

Docket Number (Optional)

S-96306

Application Number

09/759,781

Applicant(s)

Rau et al

Filing Date

1/11/2001

Group Art Unit

1764

U.S. PATENT DOCUMENTS

RECEIVED

~~MAY 17 2001~~

TC 1700

FOREIGN PATENT DOCUMENTS

OTHER DOCUMENTS (*Including Author, Title, Date, Pertinent Pages, Etc.*)

EXAMINER

DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE CITATION

(Use several sheets if necessary)

MAY 14 2001

Docket Number (Optional)
S-96306Application Number
09/759,781

Applicant(s)

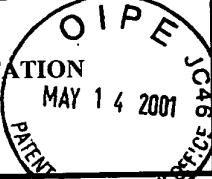
Rau et al

Filing Date

1/11/2001

Group Art Unit

1764



*EXAMINER INITIAL	OTHER DOCUMENTS (Include Author, Title, Date, Pertinent Pages, Etc.)
C1	"Carbon Dioxide Recovery and Disposal From Large Energy Systems", H. Herzog and E. Drake, published in Annual Reviews of Energy and Environment Vol. 21, p 145-166, dated 1996
C2	"Mitigation of CO ₂ by Chemical Conversion: Plausible Chemical Reactions and Promising Products", Y. Xiaoding and J.A. Moulijn, published in Energy and Fuels, Vol. 10, No. 2, p 305-325, dated 1996
C3	"The Fixation of Carbon Dioxide in Inorganic and Organic Chemicals", M. Aresta, published in Energy Conversion and Management, Vol. 34, No. 9-11, p. 745-752, dated 1993
C4	"The Carbonate-Silicate Geochemical Cycle and its Effect on Atmospheric Carbon Dioxide Over the Last 100 Million Years", R.A. Berner, A.C. Lasaga, and R.M. Garrels, published in American Journal of Science, Vol. 283, p 641-683, dated September 1983
C5	"Marine Carbonate Formations: Their role in Mediating Long-Term Ocean-Atmosphere Carbon Dioxide Fluxes - A Review", C.N. Murray and T.R.S. Wilson, published in Energy Conversion and Management, Vol. 38, Supple., p. S287-S294, dated 1997
C6	"Multiple timescales for neutralization of fossil fuel CO ₂ ", D. Archer, H. Keshgi, and E. Maier-Reimer, published in Geophysical Research Letters, Vol. 24, No. 4, p. 405-408, dated February 15, 1997
C7	"CO ₂ Fixation by Artificial Weathering of Waste Concrete and Coccolithophorid Algae Cultures", H. Takano and T. Matsunaga, published in Energy Conversion Management, Vol. 36, No. 6-9, p 697-700, dated 1995
C8	"Evaluation Strategies for Chemical and Biological Fixation/Utilization Processes of Carbon Dioxide", T. Kojima, published in Energy Conversion Management, Vol. 36, No. 6-9, p 881-884, dated 1995
C9	"Absorption and Fixation of Carbon Dioxide by Rock Weathering", T. Kojima, A. Nagamine, N. Ueno and S. Uemiya, published in Energy Conversion Management, Vol. 38, Suppl., p S461-S466, dated 1997
C10	"Carbon Disposal in Carbonate Minerals", K.S. Lackner, C.H. Wendt, D.P. Butt, E.L. Joyce, D.H. Sharp, published in Energy, Vol. 20, No. 11, p 1153-1170, dated 1995
C11	"Progress on Binding CO ₂ in Mineral Substrates", K.S. Lackner, D.P. Butt, and C.H. Wendt, published in Energy Conversion and Management Vol. 38, No. 11, p S259-S264, dated 1997
C12	"CO ₂ Recovery From Flue Gas by an Ecotechnological (Environmentally Friendly) System", T. Chohji, M. Tabata, and E. Hirai, published in Energy, Vol. 22, No. 2/3, p 151-159, dated 1997

EXAMINER

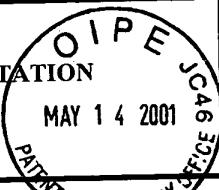
DATE CONSIDERED

*EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE CITATION

(Use several sheets if necessary)

MAY 14 2001

Docket Number (Optional)
S-96306Application Number
09/759,781Applicant(s)
Rau et al

Filing Date

1/11/2001

Group Art Unit

1764

*EXAMINER INITIAL	OTHER DOCUMENTS (Include Author, Title, Date, Pertinent Pages, Etc.)
C13	"Sequestering Atmospheric Carbon Dioxide by Increasing Ocean Alkalinity", H. Kheshgi, published in Energy, Vol. 20, No. 9, p 915-922, dated 1995
C14	H. N. Soud and M. Takeshita, FGD Handbook, Second Edition, IEA Coal Research, London, chapter 3, p. 25-43, dated January 1994
C15	"Geochemistry of Sedimentary Carbonates", Elsevier Science Publishers, p. 1-10, 72-86, dated 1990
C16	"A Continuous and Mechanistic Representation of Calcite Reaction-Controlled Kinetics in Dilute Solutions at 25°C and 1 Atm Total Pressure", T. Arakaki and A. Mucci, published in Aquatic Geochemistry, Vol. 1, p 105-130, dated 1995
C17	"CO2 Capture, Reuse, and Storage Technologies for Mitigating Global Climate Change, Herzog et al, White Paper, p 34, dated January 1997
C18	"A Geological Perspective on Global Warming and the Possibility of CO2 Removal as Calcium Carbonate Mineral", Dunsmore, Energy Conversion Management, Vol 33, No. 5-8, p 565-572, dated 1992
C19	"Carbon Sequestration - State of the Science", Working paper for roadmapping future carbon sequestration R&D, U.S. DOE Office of Science/Office of Fossil Energy, dated February 1999, p 3-13 to 3-16
C20	IEA 2000 "Capture of CO2 Using Water Scrubbing", International Energy Agency, Gloucestershire, UK. pg. 2-4 and 2-5 describes work of Rau and Caldeira
C21	U.S. Dept. of Energy report, 1999. Carbon Sequestration Research and Development. U.S. Dept. of Energy, Wash., D.C, page 3-14
C22	Wong, C.S. and S. Hirai. 1997. Ocean Storage of Carbon Dioxide - A Review of Oceanic Carbonate and CO2 hydrate Chemistry. International Energy Agency, Cheltenham, UK. pg. 54-58
C23	Golomb, G. and A. Angelopoulos, "A Benign Form of CO2 Sequestration in the Ocean", 5th International Conf on Greenhouse Gas Control Technologies
C24	Smith, H.J. 2000. Ocean Dumping of CO2. Science 287: 769

EXAMINER

DATE CONSIDERED

*EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE CITATION

(Use several sheets if necessary)

MAY 14 2001
PCT/US01/04696

Docket Number (Optional) S-96306	Application Number 09/759,781
Applicant(s) Rau et al	
Filing Date 1/11/2001	Group Art Unit 1764

RECEIVED

*EXAMINER INITIAL	OTHER DOCUMENTS <i>(Including Author, Title, Date, Pertinent Pages, Etc.)</i>	MAY 17 2001
C25	Golomb D . 1997. A fizz-sics solution: Use limestone to cure lake's CO2 problem, Physics Today 50 (2): 15-15	TC 1700
D1	Rau and Caldeira, I Science and Technology Review, December 1998, entitled "Energy To Keep Everything Running"	
D2	an abstract entitled "Geochemical implications of the carbonate-dissolution method for ocean disposal of carbon dioxide" describing this invention was presented by one of the inventors at the "Second International Symposium on CO2 in the Ocean" conference January 18-22, 1999 in Tsukuba, Japan	
D3	Rau and Caldeira, Lawrence Livermore National Laboratory (LLNL) report UCRL-JC-132228. Entitled "Enhanced Carbonate Dissolution: A Means of Sequestering Waste CO2 as Ocean Bicarbonate", it was catalogued by the LLNL library on March 15, 1999, also published in Energy Conversion and Management, vol. 40, 1999, pp. 1803-1813.	
D4	Nojiri, Y. 1999. Proceedings of the 2nd International Symposium: CO2 in the Oceans. National Institute for Environmental Studies, Tsukuba, Japan. pg. 429	
D5	Rau and Caldeira, Geophysical Research Letters, January 15, 2000, Vol. 27, No. 2, entitled "Accelerating carbonate dissolution to sequester carbon dioxide in the ocean: Geochemical implications", pp.225-228	
D6	Rau, G.H. and K. Caldeira. Enhanced carbonate dissolution as a means of sequestering carbon dioxide in the ocean. Transaction, American Geophysical Union 80(49): 213, December 7, 1999	
D7	Rau, G.H., B. Downs, K. Caldeira, and H. Sarv. Enhanced carbonate dissolution as a means of sequestering carbon dioxide in the ocean. Transaction, American Geophysical Union 81(48): 283, November 28, 2000	
EXAMINER	DATE CONSIDERED	

*EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.